

What is claimed is:

1. A frangible bullet comprising <sup>predominantly</sup> copper or a copper alloy powder and manufactured by pressing said powder in a die and subsequently sintering it under conditions so as to produce a bullet capable of fragmenting upon impact with a target.

2. The bullet of claim 1 wherein the bullet is lead-free.

3. The bullet of claim 1 wherein the powder comprises an oxide additive.

4. The bullet of claim 3 wherein the oxide additive is selected from the group consisting of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{MgO}$ ,  $\text{MoO}_3$  and combinations thereof.

5. The bullet of claim 4 wherein the oxide additive is  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{MgO}$  or a combination thereof and the amount of oxide additive is from 0.05 to 1.0 percent by weight.

6. The bullet of claim 4 wherein the powder comprises from 0.05 to 0.50 percent by weight of  $\text{MoO}_3$ .

7. The bullet of claim 1 wherein the powder is a dispersion strengthened copper

powder.

- <sup>4</sup>8. The bullet of claim <sup>3</sup>7 wherein the dispersion strengthened copper powder is made by internal oxidation of a dilute solid solution alloy of copper and a reactive element selected from the group consisting of Si, Al, Ti, and Mg.

<sup>20</sup><sub>24</sub>9. The bullet of claim 1 wherein the powder comprises a solid lubricant additive.

<sup>24</sup><sub>23</sub>10. The bullet of claim <sup>23</sup>9 wherein the solid lubricant additive is selected from the group consisting of graphite, MoS<sub>2</sub>, MnS, CaF<sub>2</sub> and combinations thereof.

<sup>25</sup><sub>24</sub>11. The bullet of claim <sup>24</sup>10 wherein the solid lubricant additive is graphite, MnS, CaF<sub>2</sub> or a combination thereof and the amount of solid lubricant additive is from 0.05 to 1.0 percent by weight.

<sup>26</sup><sub>24</sub>12. The bullet of claim <sup>24</sup>10 wherein the powder comprises from 0.05 to 0.50 percent by weight of MoS<sub>2</sub>.

<sup>46</sup><sub>28</sub>13. The bullet of claim 1 wherein the powder comprises a nitride additive.

<sup>28</sup><sub>27</sub>14. The bullet of claim <sup>27</sup>13 wherein the nitride additive is selected from the group

consisting of HBN, SiN, AlN and combinations thereof and the amount of nitride additive is from 0.05 to 1.0 percent by weight.

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15. The bullet of claim 1 wherein the powder comprises an oxide additive and a solid lubricant additive.

30  
31e  
29  
32e  
16. The bullet of claim 15 wherein the oxide additive is selected from the group consisting of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, and MgO and the solid lubricant additive is selected from the group consisting of graphite, MnS, and CaF<sub>2</sub> and the combined amount of oxide and solid lubricant additives is from 0.05 to 1.0 percent by weight.

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17. The bullet of claim 1 wherein the powder comprises a carbide additive.

32  
33e  
31  
32e  
18. The bullet of claim 17 wherein the carbide additive is selected from the group consisting of WC, SiC, TiC, NbC and combinations thereof and the amount of carbide additive is from 0.05 to 1.0 percent by weight.

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19. The bullet of claim 1 wherein the powder comprises a boride additive.

34  
35  
33  
34e  
20. The bullet of claim 19 wherein the boride additive is selected from the group consisting of TiB<sub>2</sub>, ZrB<sub>2</sub>, CaB<sub>6</sub> and combinations thereof and the amount of boride

additive is from 0.05 to 1.0 percent by weight.

21. The bullet of claim 1 wherein the powder is a prealloyed brass containing from 5 to 40 percent by weight of zinc.

22. The bullet of claim 1 wherein the powder is a mixture of copper powder and from 5 to 40 percent by weight of zinc powder.

23. The bullet of claim 1 wherein the powder is a prealloyed bronze containing from 2 to 20 percent by weight of tin.

24. The bullet of claim 1 wherein the powder is a mixture of copper powder and from 2 to 20 percent by weight of tin powder.

25. Ammunition comprising the bullet of claim 1.

26. A method of making a frangible bullet which comprises pressing <sup>a predominantly</sup> copper or a copper alloy powder in a die and subsequently sintering it under conditions so as to produce a bullet capable of fragmenting upon impact with a target.

41 27. The method of claim <sup>40</sup>26 wherein the pressing of the powder is performed at a pressure ranging from 50 to 120 ksi.

42 28. The method of claim <sup>41</sup>27 wherein the pressing is done at a pressure ranging from 60 to 100 ksi.

43 29. The method of claim <sup>40</sup>26 wherein the sintering is performed in a protective atmosphere at a temperature ranging from about 1500 to about 1900°F for a length of time ranging from about 10 to about 120 minutes.

44 30. The method of claim <sup>43</sup>29 wherein the sintering is done at a temperature of 1600 to 1800°F when the powder is copper, between 1600 and 1700°F when the powder is brass and between 1500 and 1600°F when the powder is bronze.

45 31. The method of claim <sup>43</sup>29 wherein the protective atmosphere is nitrogen or a mixture of nitrogen and hydrogen or reaction products of a combusted hydrocarbon.

46 32. The method of claim <sup>43</sup>29 wherein the sintering time is between 15 and 45 minutes.

47 33. The method of claim <sup>43</sup>26 wherein the bullet is repressed after the sintering step.

<sup>48</sup>34. The method of claim <sup>47</sup>33 wherein the bullet is resintered after repressing.

<sup>48</sup><sup>39</sup>a 35. <sup>predominantly</sup>A copper or copper alloy powder useful for manufacturing a frangible item, said powder comprising copper powder or a copper alloy powder and an additive selected from the group consisting of an oxide, a solid lubricant, a nitride, a carbide, a boride, and combinations thereof.

<sup>50</sup>36. A powder of claim <sup>49</sup>35, wherein the amount of the additive is from 0.05 to 1.0 percent by weight of the powder.

<sup>51</sup>37. A powder of claim <sup>49</sup>35, wherein the additive is an oxide selected from the group consisting of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, MgO, MoO<sub>3</sub>, and combinations thereof.

<sup>52</sup>38. A powder of claim <sup>51</sup>37, wherein the amount of the oxide additive is from 0.05 to 1.0 percent by weight of the powder.

<sup>53</sup>39. A powder of claim <sup>49</sup>35, wherein the additive is a solid lubricant selected from the group consisting of graphite, MoS<sub>2</sub>, MnS, CaF<sub>2</sub>, and combinations thereof.

<sup>54</sup>40. A powder of claim <sup>53</sup>39, wherein the amount of the solid lubricant additive is from 0.05 to 1.0 percent by weight of the powder.

<sup>49</sup>  
41. A powder of claim <sup>49</sup>35, wherein the additive is a nitride selected from the group consisting of HBN, SiN, AlN, and combinations thereof.

<sup>46</sup>  
42. A powder of claim <sup>45</sup>41, wherein the amount of the nitride additive is from 0.05 to 1.0 percent by weight of the powder.

<sup>47</sup>  
43. A powder of claim <sup>45</sup>35, wherein the additive is a carbide selected from the group consisting of WC, SiC, TiC, NbC, and combinations thereof.

<sup>48</sup>  
44. A powder of claim <sup>45</sup>43, wherein the amount of the carbide additive is from 0.05 to 1.0 percent by weight of the powder.

<sup>49</sup>  
45. A powder of claim <sup>49</sup>35, wherein the additive is a boride selected from the group consisting of TiB<sub>2</sub>, ZrB<sub>2</sub>, CaB<sub>6</sub>, and combinations thereof.

<sup>60</sup>  
46. A powder of claim <sup>49</sup>45, wherein the amount of the boride additive is from 0.05 to 1.0 percent by weight of the powder.

<sup>61</sup>  
47. A powder of claim <sup>49</sup>35, wherein the additive is a combination of an oxide and a solid lubricant.

48. A powder of claim <sup>61</sup>47, wherein the oxide additive is selected from the group consisting of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$  and  $\text{MgO}$  and the solid additive is selected from the group consisting of graphite,  $\text{MnS}$ , and  $\text{CaF}_2$  and the combined amount of the oxide and solid lubricant additives is from 0.05 to 1.0 percent by weight.

49. A powder of claim 35, wherein the copper powder is blended with from 5 to 40 percent by weight of zinc powder.

50. A powder of claim 35, wherein the copper powder is blended with from 2 to 20 percent by weight of tin powder.

51. A powder of claim 35, wherein the copper alloy powder comprises 5 to 40 percent by weight of zinc powder.

52. A powder of claim 35, wherein the copper alloy powder comprises 2 to 20 percent by weight of tin powder.

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